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AUTHOR Martinello, Marian L.; Mammen, Loretta
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ABSTRACT

A three credit undergraduate course, offered through a University of Texas Gifted and Talented Program to qualified high school students, used material objects in a museum to promote visual thinking. Fourteen students were enrolled in the course, which included four interacting units of study: (1) using the operations and strategies of visual thinking; (2) responding to the visual elements in artworks and artifacts; (3) interpreting artifacts in their historical context; and (4) designing small exhibits. A formative evaluation used a written test matched to course goals which was administered prior to, at the midpoint, and at the end of the course. Results indicated that students emphasized fact-seeking in the questions they applied to objects, and that they could respond to visual elements in describing objects but could not apply those same elements to object exhibition. The most demonstrable contribution of the course to student learning was in thematic awareness. The study suggests developmental stages for the ideation and communication of imagery. These stages assume that skill develops from the following: (1) exposure to models of expressed imagery; (2) practice in seeing wholes and parts and opportunities to repattern perceptions; (3) activities in graphic ideation which consciously remove existing labels; and (4) efforts to replace the old labels with new ones that communicate mental impressions through visuals and words. (LMM)

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DEVELOPING AND ASSESSING VISUAL THINKING

Marian L. Martinello
The University of Texas at San Antonio

Loretta Mammen
Comal Independent School District, Texas

Imagery is the stuff of perception. It is at the heart of the creative process. If, according to Arnheim,[1] all thinking is based on perception, it follows that the quality of thinking is determined by the fullness of seeing. The development of visual thinking should, therefore, be a high priority in education.

There is very little evidence to suggest that schooling is intended to develop visual thinking abilities. Attention to them is reserved for education in the arts and that, unfortunately, is not generally recognized as important for everyone. The fact is, however, that opportunities for visual learning abound in the daily lives of most people, not only those in the arts. The richness of our perceptions of even the most mundane is determined by our abilities to look beyond the superficial, to see more than the impressions left by the first glance.

In viewing films and television, the ability to process non-linear images influences the viewer's understanding of the visual communication. In reading and in listening, imagery is required for fullness of comprehension. In analyzing problems, ability to visualize patterns is often crucial to finding solutions. Response to and interpretation of artforms and artifacts cannot proceed without visual thinking.

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Recentering, the ability to take differing perspectives on a subject, idea or thing, must be initiated with the concrete: the grain of sand, the wild flower. Early studies of any subject or process are best advanced through concrete experiences. So it is with visual thinking. And what better focus for education in perceiving than the things that comprise our material culture?

A natural relationship exists between visual thinking and material culture research in curriculum design which seeks to systematically and simultaneously develop young people's perceptual and inquiry skills. The objects people have made and used are concrete. They can be sensed directly and examined from differing perspectives. They are subjects for historical and cultural interpretations which are contingent on the perspectives from which one looks. Those perspectives can be enlarged by awareness of how the mind's eye thinks.

Learning to respond to the visual elements of line, light, color, shape, mass, texture, space, time, and motion[3] in artworks and artifacts is one dimension of education in visual thinking. It enables the viewer to see overall patterns and to repattern. McKim refers to this as one of several visual thinking strategies.[4] The descriptor he applies to the process of seeing the Gestalt is abstracting. The use of metaphors, similies, and analogies describes aspects of the transforming strategy. Concretizing is concerned with seeing details and recentering attention to sharpen representational perspectives. The application of historical knowledge to find meanings in visual experience is an aspect of

The current emphasis in education at all levels is a highly verbal one. Skill in understanding the printed word is pursued often without planned effort to develop the imagery essential to comprehending verbal communications. Few experiences in learning how to derive meaning from visuals are offered students in school curricula. Neither are they helped to communicate in visual and symbolic ways. The result is visual illiteracy.

Concern for the development of rational thinking in young people is reflected in the increasing importance expressed for instruction in the sciences and mathematics. It is curious that the development of perceptual skills, imagery, and imagination, which figure prominently in discovery, invention, and creative problem solving is rarely discussed as corequisite to inquiry. Ability to see the uncommon in the common and to imagine possibilities in the mind's eye is well represented in the self-reports of those who have contributed to the knowledge of their discipline of study. Imagery is essential to inquiry.

How does one learn to see the uncommon in the common, to enlarge the perceptions of the mind's eye for creative inquiry? The curriculum question asks for a beginning--places and ways to promote the development of visual thinking operations and strategies in the novice. Another curriculum question seeks means of evaluating that development.

In The Ascent of Man, Bronowski[2] quotes from William Blakes' the Auguries of Innocence:

> To see a world in a Grain of Sand
> And a Heaven in a Wild Flower
> Hold Infinity in the palm of your hand
> And Eternity in an hour.

timescanning, a visual thinking strategy which figures prominently in material culture studies. These ways of seeing interact with the skills of inquiry to structure the logic of interpretation. On these premises, a course in visual learning and humanities research was designed for secondary students. The report of its content and the means used to evaluate student learning is reported in the following sections of this article.

The Program

The Gifted and Talented Student Program at The University of Texas at San Antonio (UTSA) offers qualified high school students opportunities to take undergraduate course work for college credit during a five-week summer session. Applicants are solicited from the San Antonio Metropolitan area. Each applicant is asked to state preferences for three of eleven courses offered in a variety of disciplines, to submit an academic record, name references, and write a statement of purpose. Candidates for each course are selected by the faculty member teaching the course on review of the applications with support materials and after interviews with each candidate. Students who are accepted for a particular course are also admitted to the program and the University as Freshmen. The undergraduate credit they earn through completion of the three semester hour course in which they enroll and a one semester hour humanities course, taken concurrently and required of all students admitted to the program, is credited toward their undergraduate degree hours. Those credit hours are transferrable to other institutions of higher education.

One three semester hour course that is offered by the program is in visual thinking and material culture studies. It was designed by the senior author in collaboration with the Education Department of the San Antonio Museum Association to help students enlarge their perceptions and apply them to object study.

The Students

Fourteen fifteen-and sixteen-year-olds were invited to enroll in the course. The group was comprised of 9 girls and 5 boys, selected from a pool of more than 200 applicants for The UTSA Gifted and Talented Student Program. Selection was made with reference to the students' overall academic record, their interest in course studies which was assessed during interviews, and their responses to a set of questions which were developed to evaluate growth in visual thinking. (The instrument and the data it collected are described and discussed in the sections that follow.)

Those who comprised the class were from eleven high schools in the San Antonio Metropolitan area. Four were of Hispanic backgrounds; the remainder were Anglo. All were from families of middle socio-economic status.

The Course of Study

Four interacting units of study comprised the course in visual thinking and material culture studies: (1) using the operations and strategies of Visual Thinking as described by McKim, (2) responding to the visual elements in artworks and artifacts, (3) interpreting artifacts in historical context, and (4) designing small exhibits. An overview of course experiences follows

to suggest how connections were forged between the use of visual thinking strategies and the processes of material culture study.

Artworks of varied styles and periods in San Antonio's Museum of Art provided the focus of early course experiences to develop the students' understanding of visual communication. They were discussed in terms of how the elements of line, shape, light, color, texture, mass, space, time, and motion encourage the viewer to abstract, to see from different perspectives, and to note details in thematic contexts. The influence of visual elements on perceptions was studied in paintings, photographs, sculpture, architecture, and artifacts of Frontier Texas Life.

Photographs provided an important link between visual response to art and ways of viewing historic artifacts. The collections of old family photographs in each of the students' homes proved to be invaluable aids. Tintypes, photographs of old homesteads, and of parents and grandparents in their younger days prompted much discussion and historical inquiry. The students used Schlereth's suggestions for interpreting photographs as sources of historical data.[5] As they attempted to read those old photos, drawing information about the people, their times, and the places in which they were photographed from the details embedded in the scenes, the students were encouraged to add interpretive questions to the fact-seeking ones that tended to dominate their inquiry.

The students' first approach to the study of primary documents as historic artifacts was made in the UTSA Special Collections Library. Somewhat dependent on the encyclopedia for

research, these young people were not accustomed to thinking of letters, maps, catalogs, legal papers and other primary documents as reference materials. Selected documents from the library's San Antonio and Texas collection were examined for the stories they told. The students perused San Antonio city directories from the early Twentieth Century first for evidence of family names, occupations, places of work and residence. Human referents were sought in every document. A post-Civil War program of activities in San Antonio for veterans led the students to imagine what they might have seen in the city if they had been present at the time. A letter written by Burnet making critical comments about Sam Houston peaked their curiosity about some personal aspects of history that are rarely treated in high school textbooks.

When they examined a 1903 street map of San Antonio, the students' first inclination was to look for the location of their present residence. The next was to find areas of the city they knew. And then they began asking questions about the way the city has changed and why.

Walks along San Antonio's downtown streets to look for time collages helped to answer some of the questions prompted by the maps. So many buildings from different time periods exist side by side in the city that the students requested stops at almost every corner to discuss the time periods represented along each block. Architectual differences were noted as buildings were examined for the architect's use of the visual elements seen earlier in museum artworks.

Historic house museums in San Antonio, including the Spanish colonial governors' residence and the home of a founder of the Republic of Texas also offered opportunities for timescanning. Their form, style, material, and the artifacts they contain all became sources of interpretive questions. The comparison of the students' homes with those historic houses led to some interesting questions about changes in life styles over time and interpretations of people's use of interior space and furnishings.

Translating images in to words uses the language of metaphor and analogy. The Texas Furniture exhibit at the San Antonio Museum of Art offered the students excellent opportunities to examine the visual elements in furniture design and display which can contribute to metaphoric descriptions. They were guided to examine nineteenth century wardrobes, beds, cabinets and chairs for the presence and interactions of line, light, color, shape, mass, texture, space, time, and motion to: (1) highlight details, (2) recenter attention, (3) reflect the aesthetic and functional perspectives of craftsmen and owners, and (4) provide foci for the selection of metaphoric descriptors. Practice in creating metaphors, similies, and analogies also was provided in the examination of a wide variety of objects from nineteenth century Texas households. Kitchen utensils, stoves, laundry implements, tools, clothing, quilts, and diverse remnants of farm life at the Sauer-Beckmann Living History Farmstead in the LBJ National Park near Stonewall, Texas were particularly valuable for the study and description of objects in historical context. Contextual clues to object interpretation proved to be significant

for the development of students' abilities to use visual thinking strategies for material culture studies.

Assignments in Visual Communication

In addition to providing the students with many artifacts to study, the University of Texas Institute of Texan Cultures and the three museums of the San Antonio Museum Association offered examples of exhibits and galleries which served as important resources for three course assignments: (1) a material culture research project, (2) a gallery tour, and (3) a small exhibit, based on the material culture research project.

The material culture research project required the students to research an object from the San Antonio Museum Association's collection of Frontier Texas artifacts. Interpreting the object's historical-cultural context was more important than documenting its history. This proved to be a difficult task for most. The students reported very limited experience with research involving the use of primary sources. None of the fourteen students had participated in material culture research prior to taking this course.

Another assignment required the students to apply their course learnings to the docent role. They were responsible for conducting an interpretative tour of an exhibit at the San Antonio Museum of Art for the remaining 112 students enrolled in the UTSA Gifted and Talented Student Program. Each of the fourteen students guided eight peers through the exhibit, focusing the tour on a theme defined by exhibited objects. Their inclination toward didactic teaching was discouraged. Instead, the students were guided to use questions and visual thinking exercises to engage

the viewer with the exhibited artifacts and to cause the viewer to discover the interrelationships among them. Attention to visual elements and principles of design was encouraged.

The third assignment was the design of a small exhibit on a theme drawn from the student's material culture research. This was intended to develop student abilities to communicate in visual and symbolic ways. The exhibit assignment encouraged the students to clarify the theme of their material culture research, to seek visuals to complement the artifact selected for display, and to attend to the interaction of visual elements in exhibit design.

Throughout the process of creating their exhibits, the students were helped by the technical leaflets published by the American Association for State and Local History, especially those on exhibit design, artifact interpretation, and the preparation of labels.[6] Visits to selected exhibits in San Antonio museums were made to examine and critique exhibit design. The students were asked to note those elements of exhibition which helped or hindered the viewer's interaction with objects on display.

In some ways, the sharp focus of the students' exhibits on the object each had researched made easier their application of design ideas, garnered from observing museum exhibits, to their own. That focus also made possible the use of inexpensive materials for object presentation. For some, the sharp focus was a liability when it tunneled attention to the particulars of the object itself, diminishing the meanings of its human context. The exhibit assignment proved to be the best single indicator of the students' skill in visual synthesis--the integration of visual ideation and problem-solving for visual expression.

THE QUESTION OF LEARNING

No matter how substantive, well-organized, and apparently motivating a course of study may be, its effectiveness must be measured in terms of student learning. Chapman[7] speaks to the importance of formative evaluation of the educational quality of museum programs through the evaluation of prototypes in the process of development. The difficulties inherent in assessing visual thinking are many and well known to museum educators. In addition to using verbal ways of determining the visual images of individuals who are not comfortable with graphic communication, the method of assessment must be easy to administer, relatively straightforward to score, and cost-effective. Above all, it must test for student growth in those visual thinking skills which the instructional experiences attempt to nurture.

An effort was made to conduct a formative evaluation of the experiences which comprise the course of study in visual learning and material culture studies by using a written test matched to the instructional goals of the course. The intent was to assess student growth in visual response to and expression through artifacts in order to identify the strengths and weaknesses of the program in promoting the desired learnings. A related purpose was to initiate test construction which might prove useful in museum education.

Assessment of Student Growth in Visual Thinking

The instruement used to evaluate the students' abilities to inquire into objects, respond to their visual elements, graphically express their characteristics in historical-cultural contexts

through exhibit design, and think in metaphoric ways about them is comprised of four questions. Each question is addressed to one of the abilities listed above and may be applied to any object. The questions read as follows:

1. What questions would you like to ask about this object?
2. What words would you use to describe this object?
3. Where and how would you display this object? Describe the place and explain why you would choose it.
4. Complete this phrase: This object is like...

The first question seeks to determine what types of questions students asked about an object: factual or interpretive. Questions seeking facts were those that ask: who made the object? How old is it? How was it used? These questions seek one correct answer. By contrast, interpretive questions entertain more divergent responses and often involve imagery on the part of the students as they interact with the object. Such questions include references to the object's meanings for the maker, user, and viewer. For instance, interpretive questions about a pre-Columbian figure include: Why does he seem to be "dressed up" to play the drum? What does his facial expression mean? What kind of person is this? Student questions were categorized by these two types to determine the total number of each type used in response to the first test item.

Question 2 attempts to measure the student's response to the visual elements in an object. All descriptors supplied by the respondent were coded for reference to any of the nine visual elements defined by Preble: line, shape, light, color, mass, space, texture, time and motion. The number of those nine elements

referred to by the descriptors was recorded; each element counted only once no matter how many descriptors were listed which refer to it. For example, the words bright, glistening, and shimmering all were interpreted as referring to the visual element of light. Therefore, only one visual element, light, was recorded for the three descriptors supplied by the same student.

In a few cases, one word was used which appeared to refer to more than one visual element. The word shiney, for example, can refer to light and/or texture. In those cases, the number of visual elements suggested by the descriptor was recorded. Also noted was the number of feeling words used and the total number of descriptors listed.

Sample descriptors for each visual element and for the expression of feelings about the object include the following:

Line: long, short, straight, curving, melodious

Shape: round, deep, flat, pointed, contoured

Light: shiney, bright, sparkling, warm, cool, lustrous

Color: warm, cool, faded, vivid, pale, gold

Texture: smooth, fragile, rough, hard, soft, bumpy, shiney

Mass: light, thick, thin, skinny, firm, bulky, small

Space: open, closed, hollow, empty, full, enclosed, spacious

Time: old, ancient, antique, new, infinite, young

Motion: moving, shaking, frozen, calm, rigid, quiet

Feeling: beautiful, precious, happy, sad, mysterious, festive

The third question about exhibiting the object is intended to assess the student's ability to apply the visual elements defined by Preble to the object's exhibition. The number of visual elements applied to exhibiting the object in the student's response was

counted; each element was tallied only once, no matter how many times it was referred to in the response. In addition, the number of themes the student referred to in response to question 3 was recorded as well as the number of references the student made to communicating different feelings to the viewer.

Examples of some student responses to the question about object display follow with notation of the visual elements mentioned or implied, and whether themes and/or feelings were communicated:

On a Double M Branding Iron

I would display this object in my garage because it is crude (texture). It seems to belong with other tools (theme).

The location would have the panelling associated with western decor (theme). I would choose this place because the object projects the image of cowboys trying to round up cattle for branding (motion, time).

Since it is a branding iron and looks like something used in the country, it could go with other objects pertaining to ranch life (theme). Also, it could be displayed by itself. It makes a strange shadow when the light hits it (light).

On a PreColumbian Drummer

Much, much larger (say 50x) and in front of the Modern Museum of Art (mass) and because I feel that this piece of art is "modern ancient" art. It appears to be made recently but symbolizing an ancient time (time).

I would display it in an empty, well lit room (light) on a single table in the center

> of the room (space). I would set it alone so others would be able to see every part of it. I would not put a glass covering over it, but leave it in the open (space)so others would be able to touch it and see and feel every aspect of it (texture).

The last question asks for completion of a simple metaphor: This object is like... Responses were coded for reference to the object's: (1) form or function, and (2) imagery, differentiated as abstract or concrete.

Some coded examples follow:

On a Double M Branding Iron

> This object is like a coatrack (form, concrete imagery)
>
> Slinkies, following each other down a stairwell (form, abstract imagery)
>
> Like a double-headed snake (abstract imagery)
>
> Like a lamppost (form, concrete imagery)
>
> Like two models of a modern chair (abstract imagery)

This set of four questions was asked of the fourteen students during three testing sessions which were held prior to, at the midpoint, and at the end of their course experiences.

A pretest was administered to all students applying to take the course in visual learning and material culture studies in March of 1982. A preColumbian figure of a drummer was used as the object. Only data collected from the fourteen students who completed the course are reported here.

A midpoint test was administered to the fourteen students enrolled in the course. The test was given in June, 1982, two and one-half weeks after the five-week course had begun. A pair of World War I soldier and nurse dolls served as the objects.

The posttest was administered at the end of the five-week term, in July, 1982. A branding iron with a double M brand was the object to which all questions were applied.

The authors first independently coded the students' responses to each question. Differences in codings were resolved through a collaborative effort to clarify criteria for the content analysis of responses. This resulted in one set of codes for each student's response to the questions on all tests to which both authors agreed. Table I presents frequencies of response types, means, and standard deviations for pre-, mid-, and post-tests. Also reported in Table I are the F scores obtained from one-way analyses of variance to determine the statistical significance of changes in scores from pre- to posttests.

Asking questions. The students were more inclined to ask questions that sought facts about an object than to explore its meanings. This tendency persisted on all tests. The mean number of fact-seeking questions in pretest responses was 5.07 (SD=2.38) as compared to 2.14 (SD=2.33) for interpretive questions. On the midtest, the comparable means and standard deviations were 4.79 (SD=1.69) for factual questions and 3.0 (SD=0.92) for interpretive types. By the last test, the mean for factual questions had risen to 7.14, with an SD of 2.36, while that for interpretive questions dropped to 1.36 (SD=1.39).

On one-way ANOVAS to compare pre- and posttest performance on this question, F ratios were found significant at the .05 level for factual questions (F=4.99) and for total questions (F=4.75) asked. The F score for interpretive questions was not significant. Although the meaning of a .05 probability level is tenuous for the sample size of fourteen students, these findings suggest that the students were generating more questions for "reading" an object by the end of the course than they were prior to course experiences. That the apparent growth was limited to fact-seeking questions raises some important considerations for course experiences which are addressed later in this paper.

Describing objects. An increase in the number of visual elements referred to by the descriptors students used for each object on the respective tests was evident from pre- to posttest performance. On the pretest, the mean for visual elements was 1.71 with a large standard deviation of 1.39. The mean was higher on the midtest, 2.43 and the standard deviation lower, 1.17. The posttest mean of 3.21 with a standard deviation of 1.78 showed further increase in student responsiveness to visual elements when looking at objects. There was no substantial change in the means for feeling descriptors. They were 1.96 (SD=1.55) on the pretest, 2.0 (SD=1.81) on the midtest, and 1.14 (SD=1.55) on the postest.

Place Table I about here

The students recorded many descriptors which could not be classified as referring to visual elements or feelings. Therefore, totals for this item in Table I do not equal the sum of descriptors for visual elements and feelings. The pretest mean for total descriptors was 6.71 (SD=2.37). On the midtest, the

TABLE I

FREQUENCIES, MEANS, AND STANDARD DEVIATIONS FOR SECONDARY STUDENT PERFORMANCE ON PRE-, MID-, AND POSTTESTS OF VISUAL THINKING AND F TESTS FOR PRE-POSTTEST COMPARISONS (N = 14)

Question/ Response Type	Pretest f	Pretest $\bar{X}$	Pretest SD	Midtest f	Midtest $\bar{X}$	Midtest SD	Posttest f	Posttest $\bar{X}$	Posttest SD	F (df_1=1; df_2=26)	p
1. Questions about object											
Factual	71	5.07	2.38	67	4.79	1.69	100	7.14	2.36	4.99	.05
Interpretive	30	2.14	2.33	42	3.00	0.92	19	1.36	1.39	1.68	.10
Total	111	7.93	2.49	109	7.79	2.78	119	8.5	2.67	4.75	.05
2. Object Descriptors											
Visual Elements	24	1.71	1.39	34	2.43	1.17	45	3.21	1.78	5.74	.05
Feelings	26	1.96	1.55	28	2.00	1.81	16	1.14	1.55	1.42	.10
Total	94	6.71	2.37	105	7.5	2.29	124	8.36	4.49	2.32	.10
3. Object Exhibition											
Visual Elements	22	1.57	1.87	17	1.21	1.14	20	1.43	1.54	—	
Feelings	4	0.29	0.45	5	0.36	0.48	2	0.14	0.35	—	
Themes	4	0.29	0.45	11	0.79	0.56	18	1.29	0.45	31.77	.001
4. Object Metaphor											
Form/ Function	1	0.07	0.26	3	0.21	0.41	6	0.43	0.50	--	
Concrete Imagery	2	0.14	0.35	7	0.50	0.50	7	0.50	0.50	--	
Abstract Imagery	8	0.57	0.50	4	0.29	0.45	9	0.64	1.04	--	

mean was 7.5 (SD=2.29). The posttest mean rose slightly to 8.36 and the standard deviation increased to 4.49.

The F score of 5.74 for pre- posttest comparisons was significant at the .05 level. Again, the small sample size argues against viewing the apparent growth with unquestioned confidence. Nonetheless, the lack of significant differences for pre- and posttest comparisons of feeling and total descriptors suggests that the finding for visual elements is noteworthy.

Exhibiting objects. The findings for visual elements referred to in the students' descriptions of how they would exhibit given objects were less encouraging than those for the presence of visual elements in their descriptors for each object. Virtually no change occurred in the number of visual elements included in the ways the students suggested displaying the objects on pre-, mid-, and posttests. The pretest mean of 1.57 (SD=1.87) was essentially matched by the midtest mean of 1.21 (SD=1.14) and the posttest mean of 1.43 (SD=1.54). The communication of feelings was sparcely represented in their descriptors. Frequency counts show only four references to feeling on the pretest, five on the midtest, and two on the posttest. These raw data also indicate the number of students referring to the communication of feelings on each test.

By contrast to findings for visual elements and feelings, references to thematic contents for object display show dramatic change from pre- to posttests. The mean of 0.29 (SD=0.45) for thematic reference on the pretest increased to 0.79 (SD=0.56) on the midtest and jumped to 1.29 (SD=0.45) on the posttest. An F

score of 31.77 for comparison of pre- and posttest references to themes was significant at the .001 level! Indeed, the raw data clearly shows that while only four students made thematic references on the pretest, all students made them on the post-test, some referring to multiple themes in their answers to the question on object exhibition.

Making metaphors. Student performance on the question which sought a simple direct metaphor for the object did not demonstrate any substantial change from pre- to posttests. The low frequencies and means for references to form and/or function and to concrete or abstract imagery in metaphors written on all tests argued against further analysis of differences. The means for form/function references were less than 0.5 on all tests with standard deviations as large or larger. The mean for concrete imagery was 0.14 (SD=0.35) on the pretest, rising insubstantially to 0.50 (SD=0.50) on both mid- and posttests. Abstract imagery had a mean of 0.57 (SD=0.50) on the pretest, 0.29 (SD=0.45) on the midtest, and decreased to 0.64 (SD=1.04) on the posttest. The large standard deviation is a result of four abstract images recorded by one student while only four additional students wrote one abstract metaphor each.

MEANINGS FOR DEVELOPING AND ASSESSING VISUAL THINKING

Admittedly, the instrument used in this study to assess growth in visual thinking has limitations. For one, it is a written test and language is neither the only mode for expressing imagery nor is it the easiest to use. Further, the test does not tap all possible dimensions of learning how to see more in things.

But it does examine students on their use of specific skills which the course in visual thinking and material culture studies intends to develop. The test results suggest which of those skills course experiences appear to have nurtured and which need attention. They also have implications for test construction.

Test results make clear the heavy emphasis on fact-seeking in the questions the students applied to objects. While the total number of questions asked increased from pre- to posttests, this may be more a function of the particular objects the students were responding to than of an increased propensity to ask questions: a branding iron may generate more questions in the minds of Texan teenagers than a preColumbian figure. For the course and the test, this finding recommends that students be asked first to interpret objects about which they have some knowledge and then objects of less familiarity to them. Class exercises in interpreting objects should include guided inquiry into varied artifacts with their presentation organized from the most to the least understood. The questions McKim suggests for the visual thinking strategy of Timescanning can contribute to student growth in reading familiar and strange objects: What from the past can help you now? What from the now can help you now?[8] These questions and their correlates may be especially useful in prompting interpretive thinking. This is an important educational purpose of courses like the one described here and experiences in museums where humanities content is presented in graphic ways.

The students tested seem to have learned how to respond to visual elements in describing objects but not how to apply those

same elements to the exhibition of the objects they described. To be sure, responding to an image is less demanding than creating a graphic communication. It may take all of a five-week course of study to become sufficiently aware of visual elements in objects to be able to consistently see them. That awareness must precede expression through and with those elements. And, perhaps the ability to express through and with visual elements must be accomplished graphically before it can be accomplished linguistically. The students' poor performance in creating metaphors offers additional evidence for this developmental approach to education in visual thinking.

The course in visual thinking and material culture studies offered varied experiences in responding to artworks and artifacts, describing images generated by them, and inquiring into their historical-cultural meanings. A developmental sequence was not attempted; rather the students were encouraged to find their own sequences and syntheses. The course may be made more effective through the sequencing of experiences from visual perception to graphic ideation followed by graphic expression and, ultimately, its translation into words. McKim's reference to visual thinking strategies[9] is particularly relevant for this sequencing. Students may profit from attending to details in objects (<u>concretizing</u>) and then withdrawing from them by repatterning to find the Gestalt (<u>abstracting</u>). Their imagery may also be enhanced by exercises in making imaginative rearrangements of the elements they perceive, transposing them and superimposing those elements to see from different perspectives (<u>manipulating</u>). Practice in abandoning stereotyped labels for things and seeking new ones which are

natural descriptors of their images for those things may develop their abilities to see and express graphic and verbal metaphors.

An instrument to assess growth in ability to use these visual thinking strategies may discover more about the students' visual imagery by asking for graphic as well as verbal descriptions. Student responses to the question which calls for a description of ways to exhibit an object may be more telling of their imagery if it were to solicit a sketch or, better yet, the exhibit itself. In fact, the course assignment which required students to create a small exhibit for the object they were studying did demonstrate the degree to which they were able to apply the visual elements studied in the course to visuals they knew and understood. Perhaps their self-reports of the exhibit design process would clarify their use of strategies for visual thinking.

The most demonstrable contribution of the course to student learning was in thematic awareness. This was an explicit component of class exercises and course assignments. Seeing objects in their historical-cultural context was not a perceptual tendency for most of the students at the outset. Finding those contexts became especially important when the students were struggling to "get information" about the objects they were given to research. It may be that the rather narrow initial focus of their object studies made possible the broadening of their perspectives. Finding the theme became the humanities puzzle created by object study. That exercise seems to have contributed to the students' thematic sensitivities.

The instrument used in this study to assess growth in visual thinking can discover and document student growth in some dimensions of visual thinking in object study. Its simplicity increases its attractiveness but limits its sensitivity to images that are not readily expressed through words. Further development of the instrument is in progress to include opportunities for graphic ideation, as suggested in the discussion of study findings. The intent is to create a means of assessing sensitivity to visual elements and ability to apply visual thinking strategies to object study which is relatively easy to administer and to score in both classroom and museum situations.

Perhaps the most important product of this study is its suggestion of developmental stages for the ideation and communication of imagery. This hypothetical construct assumes that richness in imagery develops from: (1) exposure to models of expressed imagery, both graphic and verbal, (2) varied practice in seeing wholes and parts combined with structured opportunities to repattern perceptions, (3) activities in graphic ideation which consciously remove existing labels and (4) efforts to replace the old labels with new ones that communicate through visuals and words, the impressions of the mind's eye. Visually talented people may synthesize experiences of those types for themselves. Others may need more direction in doing so.

The contruct outlined here will serve as a guide for the development of the course in visual thinking and material culture studies which will be tested with a revised form of the assessment instrument used in this study during the summer of 1983.

The intent is to clarify ways in which visual thinking skills may be developed in a relatively short time frame and through experiences that can be offered in classrooms and museums for those whose use of imagery has been limited. Through such efforts, the stuff of perception may be better defined and understood for the education of visual thinkers in schools and museums.

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